Pilojection* for Intracranial Aneurysms

Report of Progress†

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In 1962 the production of thrombosis within an intracranial aneurysm by pilojection was achieved for the first time. Using shafts of hog hair delivered under high velocity into the wall of the sac, a large aneurysm of the anterior cerebral artery was closed by thrombosis. In reporting this case, it was noted that the patient died from carotid thrombosis caused by carotid arteriography. However, the thrombosed aneurysm was recovered at autopsy. In January 1963 the successful treatment of 3 other patients by pilojection was recorded. Up to February 1963, this procedure has been used on 16 patients with aneurysm including 1 patient with an arteriovenous aneurysm of the spinal cord. In 9 patients the aneurysm was treated under personal supervision and in 6 others the technique of pilojection was used by other neurosurgeons with the author as an observer. The purpose of this presentation is to evaluate the successes and failures of this technique up to date and to discuss the theoretical and practical aspects of pilojection in the treatment of intracranial aneurysms.

Technique

Although the technical aspects of pilojection have been described in the earlier papers, a concise review should be useful. After the aneurysm has been partially exposed to direct vision, shafts of stout mammalian hair, either hog hair or horse hair, are propelled into the wall of the sac using a pencil-size pneumatic gun (Fig. 1). This gun was developed in the Naval Research Laboratory by Harrison P. Hagemeyer of Washington, D. C. The internal instrumentation of the pneumatic gun permits it to operate without any dangerous thrust or recoil. It is fired under pressures ranging from 45 to 50 lbs. per sq. in. and the power supply is furnished by a tank of compressed air or any other nonflammable gas such as carbon dioxide or nitrous oxide. The instrument and its connecting plastic hose are sterilized by a standard autoclave. The shafts of hair are one-quarter of an in. long (6 mm.) and are 0.005 in. in diameter (hog hair) or 0.008 in. in diameter (horse hair). The hairs are sterilized by washing them in an ordinary soap or detergent for 30 min. and then soaking them in 70 per cent alcohol for 18 hrs. When more rapid sterilization is needed the hairs can be treated in an ethylene oxide gas chamber which is now available in many clinics. For small berry-like aneurysms, 3 or 4 shafts of hair properly introduced into the sac seem to be sufficient to obliterate the lesion. For giant-sized malformations, 10 to 15 shafts of hair scattered in orderly fashion over the surface will induce thrombosis and closure.

Clinical Material

Up to Feb. 1, 1963, pilojection has been used on 15 patients with intracranial aneurysm and on 1 patient with a giant arteriovenous aneurysm of the spinal cord. There were 10 males and 6 females in the series. The youngest patient was 6 years old and this was the individual with the malformation in the spinal cord. The 15 patients with intracranial aneurysm varied in age from 34 to 71 years. In 2 patients the aneurysm was situated on the left anterior cerebral vessel, in 4 others on the right anterior cerebral, in 1 on the anterior communicating, in 3 on the...
right or left internal carotid arteries and in 5 on the trifurcation complex. The spinal lesion was located at the T5 to T7 level. Estimated measurements from the arteriograms and by direct vision showed that 6 aneurysms were about 1 cm. in size, 4 about 2 cm. in size, 3 more about 3 cm. and 1 about 4 cm. There was 1 other huge aneurysm, measuring approximately 6 cm. in length and 4 cm. in diameter. Although all of these patients were seriously ill, only 2 of them were desperately ill at the time of operation. In 12 cases, leakage from the aneurysm had occurred prior to treatment and in the remaining 4 no preoperative hemorrhage had occurred. In the 9 patients treated by the author, surgical exposure of the lesion was assisted only by continuous spinal-fluid drainage and hyperventilation. In the other 6 patients, treated elsewhere, hypothermia and/or urea and hypotensive drugs were used as surgical adjuncts.

**Surgical Results**

In most of the cases an arteriogram was performed in the operating room following pilojection and before closing the craniotomy. Complete thrombosis of the aneurysm was known to have occurred in 9 patients. In 4 more patients, the evidence indicates that only incomplete thrombosis occurred. In 2 more patients the procedure did not result in any degree of thrombosis. In the child with the aneurysm of the spinal cord there was no conclusive proof that clotting had occurred. In 2 patients the lesion had to be re-exposed and re-treated to promote thrombosis. Following the use of this procedure on 16 patients, 6 of them died, a surgical mortality of 38 per cent for the group as a whole. The 10 survivors had no neurologic deficits at the time of discharge from the hospital.

In order to clarify the surgical results the patients were subdivided as follows:

(a) **Patients With Evidence of Complete Thrombosis.** Among these 9 patients, 2 died after operation. The first patient in the series died 18 hours after operation and at autopsy the aneurysm was found to be diffusely firm and on hemisection the cavity of the aneurysm was found to be filled with clot. Microscopic examination showed that this was an antemortem thrombosis. The autopsy also revealed that there was an antemortem clot plugging the carotid siphon and that this arose from the site of the carotid punctures during arteriography. The second patient, who died even though the aneurysm had been closed by thrombosis, succumbed 8 days after operation. This individual had the largest aneurysm in the series (Fig. 2). He did well for the first 6 days after operation; then signs of increased intracranial pressure developed and the surgeon reopened the bone flap and extirpated the clotted specimen (Figs. 3 and 4). The patient died the next day. No autopsy was performed.

(b) **Patients With Evidence of Incomplete Thrombosis.** There were 4 patients in whom arteriography immediately after pilojection, or several weeks later, showed evidence of incomplete thrombosis. Three of these died later. One of them died 2 weeks after leaving the hospital apparently from subarachnoid hemorrhage and no autopsy was performed. Another patient had a large aneurysm of the trifurcation. The lesion was treated by pilojection and the arteriogram performed during the operation showed that 50 per cent of the sac was closed off (Figs. 5 and 6). Arteriograms about 2 weeks after operation showed that no progression in the clotting process had occurred (Fig. 7). The patient died 8 weeks after pilojection and, at autopsy, the clotted and unclotted portions

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**Fig. 2. Arteriogram showing huge aneurysm of middle cerebral artery, 6X4 cm.**